Electrometric aviation soot monitor, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

We propose to develop a highly sensitive and portable device to monitor soot particle mass distribution from aircraft engine exhaust. The proposed method is based on sensitive electric charge measurement on soot particles of specific mass, which was selected via Lorentz force. Through extensive investigation on soot emission from internal combustion engines over the past four decades, it has been well known that engine soot particles are usually charged. Counting particle charge at specific mass could lead to the determination of both total particle count and mass. Currently commercially available electrometric measurements on charged particles suffer from rapid signal drift, which limits its applications on soot emission measurements. In our proposed design, an amplitude modulation scheme is included to eliminate the influence from signal drift and also improve detection sensitivity. The proposed soot mass distribution monitor will be less than 50 pounds in weight and consume approximately 300W electrical power. It will also be capable of being remotely controlled and operating under vacuum condition. Since most of the components are commercially available, total cost of the proposed device could be less than $30,000.

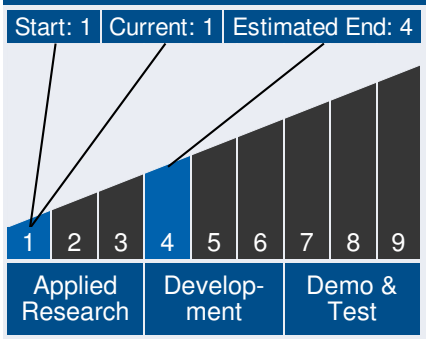
ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The primary NASA need for this technology is to measure soot particle mass distribution from aircraft engine exhaust. At present, particle mass distribution is calculated from particle size distribution, which is measured by the Engine Exhaust Particle Sizer (EEPS) and Scanning Mobility particle Sizer (SMPS) techniques. Both techniques provide information on particle count at each electrical mobility diameter. To calculate particle mass distribution, an assumption of particle density becomes necessary. Since engine soot particles are intrinsically fractal

Table of Contents

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

aggregates, their densities are complex function of particle size and compositions. Obtaining the particle density information requires sophisticated measurement instrumentation. The proposed soot mass distribution monitor will directly measure particle mass distribution, from which total particle count and mass could be determined. In the past, NASA has funded a number of field measurement programs such as EXCAVATE, APEX, UNA-UNA, and AAFEX that focus on the measurement of black carbon emissions from civilian aircraft engines.

To the commercial space industry:

Potential Non-NASA Commercial Applications: We expect that the soot particle mass monitor developed under this program will significantly benefit the scientific community interested in characterizing soot particle mass from a variety of internal combustion engines. The ability of one instrument to measure particle charge at specific mass will enable continuous measurements of particle mass distribution that can be directly used to determine total particle count and mass. In combination with an electrical aerosol charger, either with a radioactive source like 85Kr or non-radioactive source like corona discharge, this instrument will provide a direct measurement on particle count and mass simultaneously for any particles or aerosols. This measurement technique could be applied to ambient aerosol monitoring, PM emission detection, and particle manufacture process.

Management Team *(cont.)*

Principal Investigator:
- Zhenhong Yu

Technology Areas

Primary Technology Area:
Launch Propulsion Systems (TA 1)
└ Air Breathing Propulsion Systems (TA 1.3)
  └ Turbine-Based Jet Engines (TA 1.3.4)

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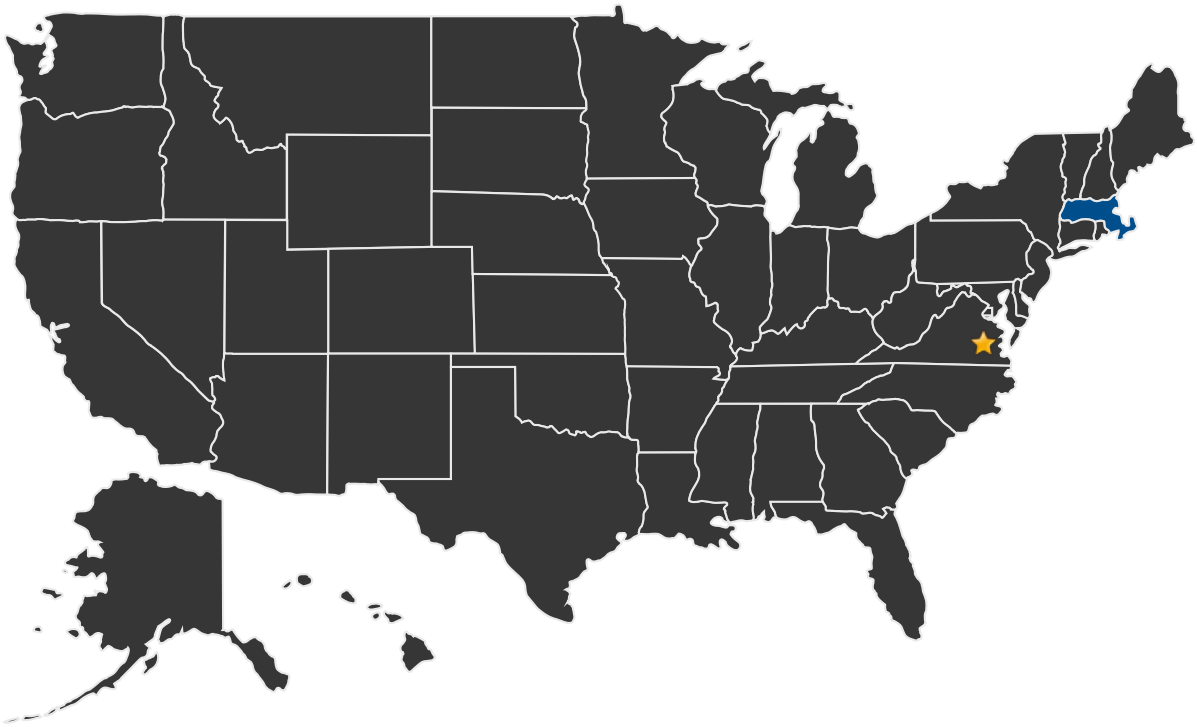
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Langley Research Center

Other Organizations Performing Work:

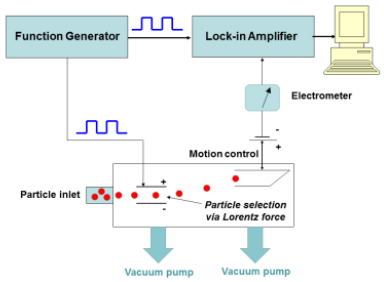
- Aerodyne Research, Inc. (Billerica, MA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23300)

IMAGE GALLERY



Electrometric aviation soot monitor, Phase I

DETAILS FOR TECHNOLOGY 1

Technology Title

Electrometric aviation soot monitor, Phase I

Potential Applications

The primary NASA need for this technology is to measure soot particle mass distribution from aircraft engine exhaust. At present, particle mass distribution is calculated from particle size distribution, which is measured by the Engine Exhaust Particle Sizer (EEPS) and Scanning Mobility particle Sizer (SMPS) techniques. Both techniques provide information on particle count at each electrical mobility diameter. To calculate particle mass distribution, an assumption of particle density becomes necessary. Since engine soot particles are intrinsically fractal aggregates, their densities are complex function of particle size and compositions. Obtaining the particle density information requires sophisticated measurement instrumentation. The proposed soot mass distribution monitor will directly measure particle mass distribution, from which total particle count and mass could be determined. In the past, NASA has funded a number of field measurement programs such as EXCAVATE, APEX, UNA-UNA, and AAFEX that focus on the measurement of black carbon emissions from civilian aircraft engines.